PATENT SPECIFICATION

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(21) Application No. 18262/75 (22) Filed 1 May 1975
(31) Convention Application No. 7416200
(32) Filed 10 May 1974 in
(33) France (FR)
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(19)

(54) DEVICE FOR ATTENUATING THE NOISE CAUSED BY A VALVE DURING THE EXPANSION OF A FLUID

(71) We, MASONEILAN INTERNATIONAL, INC., a Corporation organised and existing under the Laws of the State of Massachusetts, United States of America, of 63 Nahatan Street, Norwood, Massachusetts, 02062, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the f...

In addition to providing means for attenuating noise or cavitation phenomena, the present invention provides means that is comparatively easy to make and that can be made comparatively cheaply.

According to the present invention there is provided apparatus for reducing the pressure of a flowing fluid and attenuating fluid-expansion-generated noise including a pressure reducing valve having a downstream face and means for attenuating

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The following corrections were allowed under Section 76 on 14 July 1978:

Page 1, line 4, *after* of *delete* Massachusetts *insert* Delaware

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4 August 1978

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labyrinths, which enable successive expansions of fluid to occur while maintaining a flow rate at a substantially constant value which is lower than it would otherwise be. The result of this is that both the amount of noise due to throttling and the cavitation are reduced. Although valves of this type considerable progress with respect to the classical valves, they have the disadvantage of being expensive to make. Furthermore, the efficiency of the means used is limited by the size of the cavity in the said valve casing.

It is to be understood that in the present description and in the claims the word "valve" extends to all fluid pressure reducing valves and is not limited to any particular form of valve.

... wire layer, each pancake being arranged relative to a preceding or a following pancake so that the successive wire lattices form sinuous passages whereby fluid flowing through said tubular member is made to encounter and follow tortuous paths around the wires of each succeeding lattice, and means for retaining said pancakes in the tubular member.

As a result of this arrangement, the volume of the attenuating means is not limited by the space available in the valve casing. Moreover, it is easier to insert these attenuating means into an ordinary tubular element than to fit them into the cavity of a valve.

The sinuous passages can be of constant cross section if the fluid to be transported is not compressible, and of increasing cross

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(71) We, MASONEILAN INTERNATIONAL, INC., a Corporation organised and existing under the Laws of the State of Massachusetts, United States of America, of 63 Nahatan Street, Norwood, Massachusetts, 02062, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to apparatus for reducing the pressure of a flowing fluid and attenuating fluid-expansion-generated noise.

It is known that, when a stream of fluid is subjected to a process of "throttling" followed by an expansion, a shock wave is produced. In the case of a compressible fluid, this shock wave gives rise to a noise whichis more intense the higher the speed of the fluid and, in the case of an incompressible fluid, to a cavitation phenomenon, the magnitude of which is also related to the speed of the fluid.

It has already been proposed to provide means inside valves, for example baffles or labyrinths, which enable successive expansions of fluid to occur while maintaining a flow rate at a substantially constant value which is lower than it would otherwise be. The result of this is that both the amount of noise due to throttling and the cavitation are reduced. Although valves of this type considerable progress with respect to the classical valves, they have the disadvantage of being expensive to make. Furthermore, the efficiency of the means used is limited by the size of the cavity in the said valve casing.

It is to be understood that in the present description and in the claims the word "valve" extends to all fluid pressure reducing valves and is not limited to any particular form of valve.

In addition to providing means for attenuating noise or cavitation phenomena, the present invention provides means that is comparatively easy to make and that can be made comparatively cheaply.

According to the present invention there is provided apparatus for reducing the pressure of a flowing fluid and attenuating fluid-expansion-generated noise including a pressure reducing valve having a downstream face and means for attenuating the noise generated by the expansion of fluid flowing through said valve, the said attenuating means including a tubular member attached to the downstream face, a series of wire grill pancakes filling a length of said tubular member, each pancake spanning across and fitting within said tubular member the first pancake being substantially at said downstream face of said valve, each pancake being composed of a series of wire lattices, each lattice including a first transverse plane layer of parallel straight wires and a second transverse plane layer of parallel straight wires oriented substantially at right angles to and being welded to said first transverse plane wire layer, each pancake being arranged relative to a preceding or a following pancake so that the successive wire lattices form sinuous passages whereby fluid flowing through said tubular member is made to encounter and follow tortuous paths around the wires of each succeeding lattice, and means for retaining said pancakes in the tubular member.

As a result of this arrangement, the volume of the attenuating means is not limited by the space available in the valve casing. Moreover, it is easier to insert these attenuating means into an ordinary tubular element than to fit them into the cavity of a valve.

The sinuous passages can be of constant cross section if the fluid to be transported is not compressible, and of increasing cross

section if the fluid is compressible. In this latter case, the increase of the cross section makes it possible to maintain a relatively constant speed of flow.

The tubular element can be cylindrical even if the sinuous passages are of increasing cross-section, by giving an increasing "porosity" to the attenuating means, in the direction from the upstream to the downstream.

In the preferred embodiment of the invention, the means for attenuating the noise is constituted by a series of perforated plates each constituted by a lattice of wires, said plates being, on the one hand, arranged transverse to the longitudinal axis of the tubular element and so juxtaposed with respect to each other that the wires of each plate are displaced with respect to those of the preceding and following plates.

The method of constructing the lattice is of importance in the flow of the fluid and is preferably such that, in one plane, the fluid will meet only wires parallel to each other.

A lattice is made by the welding of a first layer of wires, parallel to each other and spaced from each other, on to a second layer similar to the first one, the wires of which are substantially perpendicular to those of the first layer. It then looks like the lattices used as reinforcement for concrete walls.

An even better lattice results from the welding of a first layer of wires in groups of two, parallel to each other and spaced with respect to the neighbouring groups, on to a second layer which is similar to the preceding one and the wires of which are substantially perpendicular to those of the first layer.

This latter form of lattice has the advantage of introducing more elliptical obstacles to the stream of fluid (two wires side-by-side have a more elongated profile than does a single wire of the same cross section).

In contrast to the first mentioned method of making a lattice the second mentioned method provides a lattice in which fluid, which has been admitted through one or several holes of the first perforated plate, depending upon the adjustment of the valve, spreads into all the passages defined between the perforated plates, moving around the obstacles formed by the wires of the lattice.

Advantageously, the attenuation of the noise by a lattice made by the second method is carried out by axially juxtaposing a series of "pancakes", each made of a series of these perforated plates joined to each other. In this way, small elements, of simple construction, are available, and they are placed side by side, in any desired number.

The device according to the invention enables use to be made, as pressure reducing valves, of a variety of valves, for example, guillotine-type valves, flap valves and plug valves. It is known that the particular valves referred to are not expensive, but that, in the present state of technology, the noise charactierics can be improved. Indeed, the variation of flow as a function of the opening (at constant loss of charge) of valves of this type is not sufficiently progressive. This defect can be corrected by inserting, downstream of these valves, a device which diffuses the stream of fluid received from them.

In order to assist in understanding the invention, there will now be given descriptions of an arrangement which is not in accordance with the invention and, by way of example, of an embodiment which is in accordance with the invention, with reference to the accompanying drawings in which:—

Figure 1a represents, in vertical section, a valve arrangement which is not in accordance with the invention,

Figure 1b is a section on the line 1b—1b of the attenuating device shown in Figure 1a,

Figure 1c is a perspective view of a truncated-cone portion of the means for attenuation employed in the arrangement of Figure 1a,

Figure 2a is a vertical section illustrating an embodiment of a device according to the invention,

Figure 2b is a section on the line 2b—2b of Figure 2a, and

Figure 2c is a perspective view of a "pancake" arrangement employed in the embodiment of Fig. 2,

Figure 3 is a graph showing, for a given ratio of pressure, the level of sound pressure [along the ordinate] as a function of the nominal frequency according to the number of pancakes used in the attenuator, and

Figure 4 is a graph comparing the level of sound pressure as a function of the upstream pressure/downstream pressure ratio, depending upon whether a classical valve or a valve having the device according to the invention is used.

In the Figures the same parts are designated by the same reference numbers.

Referring to Figure 1a, there is shown a classical plug valve, in its entirety indicated by the reference 1, provided with a convergent element 2 upstream and with a partially divergent element 3 downstream. The elements 2 and 3 are coaxial. The partially divergent element 3 comprises a truncated-cone portion 3a and a cylindrical portion 3b.

In the embodiment of Figures 1a and 1b,

the partially divergent element 3 includes means for attenuating noise of truncated-cone shape 4a, continued by means of a portion of cylindrical shape 4b. The truncated-cone part 4a, shown in Figure 1c, is made up of a combination of wavy pattern partitions 5 and plane partitions 6 which intersect and which bound between them zigzag passages 7 which are separated from each other. These passages 7 have a cross section which increases in the direction from the upstream of the part towards the downstream.

The cylindrical part 4b is formed of plane partitions 8 and 9 which intersect perpendicularly.

It will be understood that when the valve 1 is opened, the access to one or several passages 7 of the attenuating means 4a is freed. Fluid can enter these passages 7 constantly changing its direction owing to the zigzag configuration. While doing this, the fluid is able to expand progressively, without any undesirable increase of speed and, consequently, with a reduced noise. The means of cylindrical shape 4b have the function of rendering the outflow speed of the fluid uniform.

If Figures 2a and 2b are now considered, it is seen that the means for attenuation 4a are in the general form of a truncated-cone and are made by the juxtaposition of six pancakes 10 of increasing diameter. Only the first and the last of these pancakes have been drawn. One of these pancakes 10 is shown in perspective in Figure 2c. Each of the pancakes 10 is composed of a series of perforated plates 11 solidly joined to each other. Each plate is formed of a lattice resulting from the welding of series of wires 12 and 13. As is evident from Figures 2a and 2b, inside one and the same pancake, the wires of the plates are positioned with respect to each other in such a way that the possibility of straight-line passages is minimised for the fluid travelling through said plates. The fluid is constantly compelled to travel around the wires it comes up against, and to follow a winding path. It will be understood that said wires oblige the fluid to expand over the entire cross section of the pancake, even if the valve has been only slightly opened, as all passage are in communication. The six pancakes 10 are maintained in place in the cavity of the divergent tubular element 3 by a ring or by claws 14.

As an example, each of the pancakes may be of a thickness of the order of 15 to 20 mm and may be composed of wires of diameters of one or a few millimeters, the wires of one and the same layer of the lattice being respectively at distances of a few millimeters from each other.

Instead of being displaced, as is seen in Figure 2c, i.e. remaining parallel to the wires of the preceding and following plates, the wires of a determined plate can also be angularly shifted. It is to be understood that the orders of magnitude indicated above are not limitative. One must, however, refrain from reducing the distance between the obstacles provided by the wires in tubular element 3 below about 4 mm, as beyond this lower limit risks of stoppage are to be feared, except of course, if the fluid being transported is very pure.

The inlet end of the means for attenuation 4a must be located as near as possible to, at most one-tenth of one mm from the outlet from the valve in order for the functioning of the assembly to be satisfactory.

It can be considered that the effectiveness of the device is a function of its length. This statement follows from Figure 3 which graphically presents the level of sound pressure SPL (dB) as a function of the sound frequency (Hz).

This graph was obtained from experiments with an attenuating device with pancakes in combination with a plug valve of 2 in. outlet diameter (50 mm). The wires of the perforated plates were of 1.8 mm diameter and were spaced at 4 mm from each other. The pressure upstream was between 4.8 and 5.2 bars absolute.

The level of sound pressure was measured 1 metre downstream from the one or more pancakes, at 1 metre from the pipe wall downstream.

It will be recalled that the level of sound pressure, expressed in dB, is equal to 20 times the logarithm to the base 10 of the ratio of the sound pressure of the source being considered to the level of sound pressure of a reference source taken to be equal to 0.0002 microbars.

In the graph:

Curve A corresponds to the use of a single pancake,

Curve B to the use of two pancakes,

Curve C to the use of three pancakes, and

Curve D to the use of four pancakes.

It appears clearly that, for the given device the level of sound pressure decreases in proportion as the number of pancakes increases, especially in the region of high frequencies.

The progress brought about by the device according to the invention can be seen from Figure 4 which compares the level of sound pressure of a known regulating valve (Camflex) with that of a plug valve which is also known, but which has been provided with the device according to the invention.

In these two cases the CvCf of the valves was of the order of 24.

It will be recalled that:

Cv, which is a flow coefficient, is the number of U.S. gallons (3,785 litres) of water passing in a minute through a restriction when the pressure drop in passing through this restriction is 1 pound per square inch (0.069 bars).

Cf is the coefficient of critical flow which represents the rate of pressure recovery of a valve transversed by any fluid whatever and which was measured by laboratory tests.

The graph shows the variation of the level of sound pressure SPL (expressed in dBA) as a function of the ratio between the absolute pressure P1 upstream and the absolute pressure P2 downstream of the valve, the broken-line curve corresponding to the Camflex valve and the fully-drawn curve to the plug valve equipped with the device according to the invention.

In this case, the said device included six pancakes placed inside a divergent element having a conicity of 24°.

As can be seen, for certain ratios of P1/P2, the device according to the invention permits a gain of 30 dB to 40 dB.

It is to be understood that the invention is not limited to the forms of carrying it out which have been described and represented. For instance, it would be possible to put together means of attenuation form a combination of different elements, e.g. pancakes 10 and other attenuating elements. In place of pancakes 10 of increasing diameters, it would be possible to use pancakes of constant diameters, but of variable "porosity" or "opacity". For this purpose it would be possible to use, from upstream towards downstream, pancakes formed of plates, the mesh of which becomes larger and larger.

The variations in the dimensions of the mesh in a plate perpendicular to the flow permit the characteristic Cv to be easily modified as a function of the regulating assembly.

On the other hand, instead of the plug valve represented, the device according to the invention could be associated with a valve, as herein defined, of a different type. Finally, the device according to the invention can be used as well for conveying fluid in the form of a gas or a liquid.

WHAT WE CLAIM IS:—

1. Apparatus for reducing the pressure of a flowing fluid and attenuating fluid-expansion-generated noise including a pressure reducing valve having a downstream face and means for attenuating the noise generated by the expansion of fluid flowing through said valve, the said attenuating means including a tubular member attached to the downstream face, a series of wire grill pancakes filling a length of said tubular member, each pancake spanning across and fitting within said tubular member the first pancake being substantially at said downstream face of said valve, each pancake being composed of a series of wire lattices, each lattice including a first transverse plane layer of parallel straight wires and a second transverse plane layer of parallel straight wires oriented substantially at right angles to and being welded to said first trasverse plane wire layer, each pancake being arranged relative to a preceding or a following pancake so that the successive wire lattices form sinuous passages whereby fluid flowing through said tubular member is made to encounter and follow tortuous paths around the wires of each succeeding lattice, and means for retaining said pancakes in the tubular member.

2. Apparatus as claimed in claim 1 wherein the lattice wires are spaced not less than 4 millimeters apart.

3. Apparatus as claimed in either claim 1 or claim 2 wherein the lattice wires have diameters of from one to two millimeters.

4. Apparatus as claimed in any one of the preceding claims wherein the thickness of the pancakes is in the range 15—20 millimeters.

5. Apparatus as claimed in any one of the preceding claims wherein the lattices are so oriented about the longitudinal axis of the tubular member that the parallel wires of one lattice are angularly spaced from the corresponding parallel wires of the preceding and/or following lattice.

6. Apparatus as claimed in any one of the preceding claims wherein the first of the lattices in the tubular element is not more than 0.1 millimeters from said downstream face of said valve.

7. Apparatus as claimed in any one of the preceding claims wherein the pancakes are either of increasing diameter or of constant diameter but have lattices of increasing mesh size in the fluid flow direction and the respective tubular element is at least partially cone shaped or cylindrical.

8. Apparatus as claimed in any one of the preceding claims wherein said means for retaining said pancakes in the tubular member comprise a ring element received

in the tubular member and engaging the last of said pancakes.

9. Apparatus as claimed in claim 1 substantially as described herein with reference to Figs. 2A, 2B and 2C of the accompanying drawings.

JOHN ORCHARD & CO.,
Chartered Patent Agents,
Staple Inn Buildings North,
High Holborn,
London WC1V 7PZ.

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1512072 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

FIG.1A

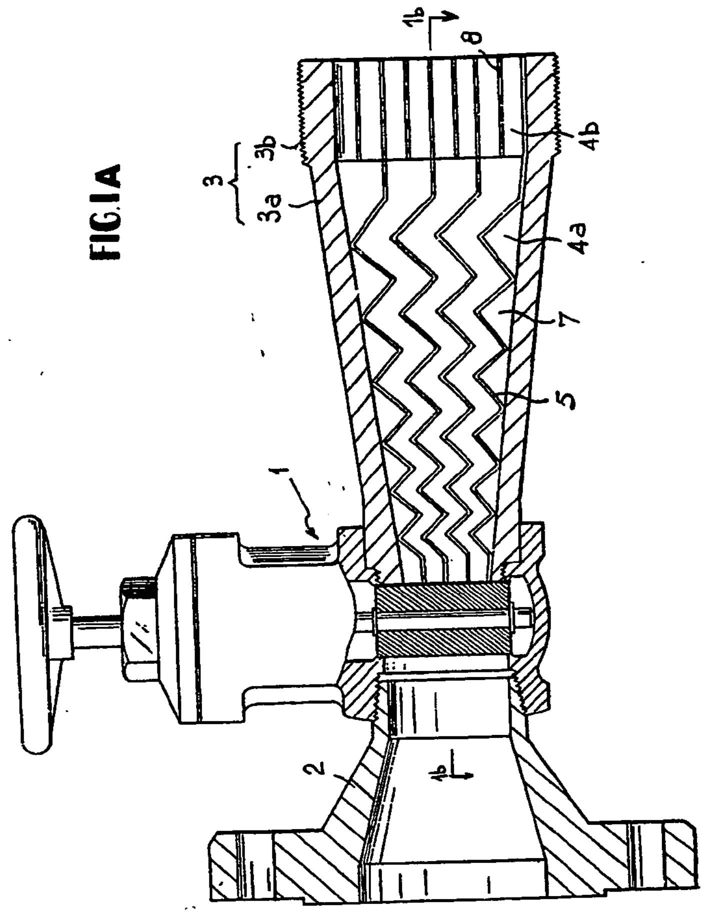


FIG.1B

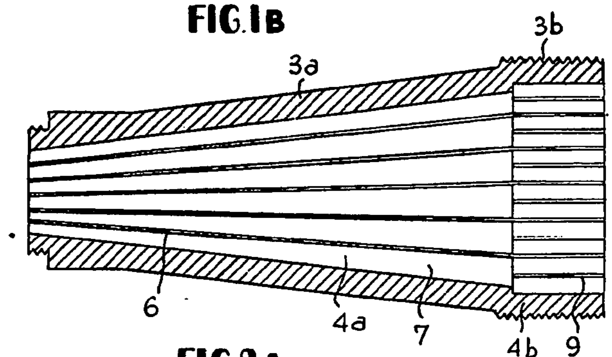


FIG.2A

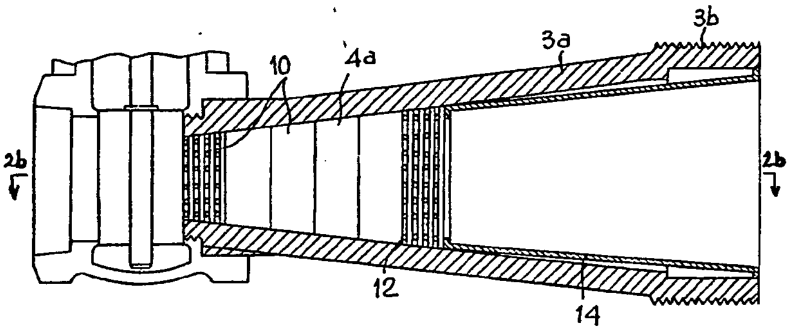
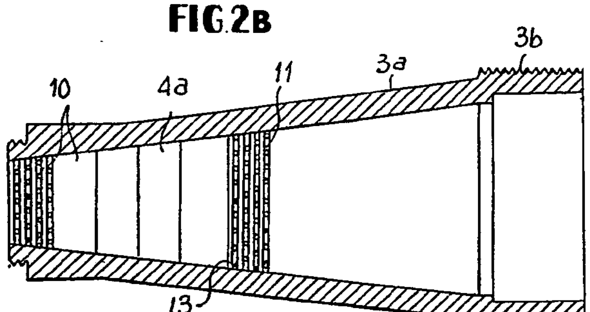


FIG.2B



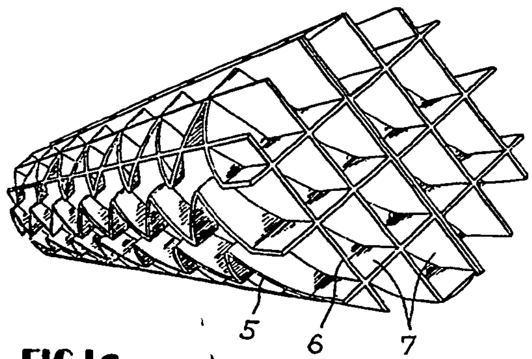


FIG.1c

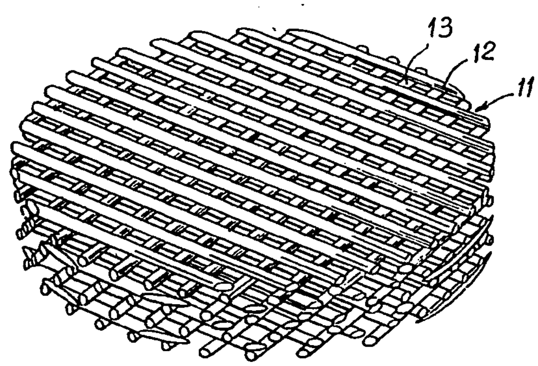
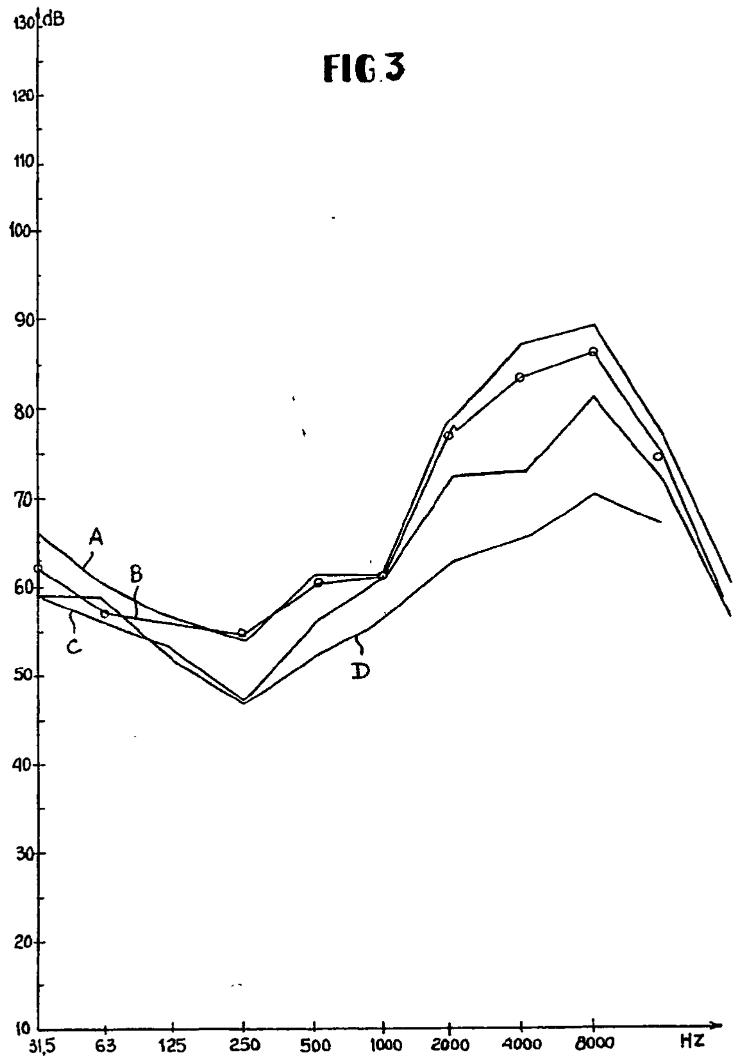


FIG.2c

FIG.3


130 dB
120
110
100
90
80
70
60
50
40
30
20
10
31,5
63
125
250
500
1000
2000
4000
8000
HZ
A
B
C
D

1512072 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 5

FIG 4